CLAIMS

We claim:

1. A device for sensing and characterizing particles by the Coulter principle, said apparatus comprising:

(a) a conduit through which a liquid suspension of particles to be sensed and characterized can be made to pass, wherein said conduit has an effective electrical impedance which is changed with the passage of each particle therethrough and wherein the conduit has a cross-sectional area of less than about 1 μm^2 and a length of less than about 10 μm;

(b) a liquid handling-system for causing said liquid suspension of particles to pass through said conduit; and

(c) a measurement system for sensing the change of electrical impedance in said conduit.

2. The device of claim 1, wherein said liquid handling-system comprises two reservoirs linked by said conduit.

3. The device of claim 1, wherein the conduit has a length, in the direction of the passage of the particles, of between about 0.1 and about 50 micrometers.

4. The device of claim 1, wherein the conduit has a length, in the direction of the passage of the particles, of between about 1 and about 10 micrometers.

5. The device of claim 1, further comprising a microfluidics or nanofluidics system for delivering the liquid suspension of particles to the liquid handling system.

6. The device of claim 1, wherein the surface of the conduit has been functionalized to reduce or enhance adsorption of the particles to said surface.

7. The device of claim 2, wherein the surface of the reservoirs has been functionalized to reduce or enhance adsorption of the particles to said surface.

8. The device of claim 1 wherein the conduit is formed at least in part by an elastomeric material.

9. The device of claim 8, wherein the elastomeric material comprises polyisoprene, polybutadiene, polychloroprene, polyisobutylene, poly(styrene-butadiene-styrene), polyurethane, poly(dimethylsiloxane) or silicone.

10. The device of claim 1, wherein the measurement system comprises a four-point electrode system.

11. A device for sensing and characterizing particles by the Coulter principle, said apparatus comprising:

(a) a conduit formed at least in part by an elastomeric material and through which a liquid suspension of particles to be sensed and characterized can be made to pass, wherein said conduit has an effective electrical impedance which is changed with the passage of each particle therethrough;

(b) a liquid handling-system for causing said liquid suspension of particles to pass through said conduit; and

(c) a measurement system for sensing the change of electrical impedance in said conduit.

12. The device of claim 11, wherein said liquid handling-system comprises two reservoirs linked by said conduit.

13. The device of claim 11, wherein the conduit has a length, in the direction of the passage of the particles, of between about 1 and about 10 micrometers.

14. The device of claim 11, wherein the conduit has a cross-sectional area of between about 1 μm^2 or less.

15. The device of claim 11, further comprising a microfluidics or nanofluidics system for delivering the liquid suspension of particles to the liquid handling system.

16. The device of claim 11, wherein the surface of the conduit has been functionalized to reduce or enhance adsorption of the particles to said surface.

17. The device of claim 12, wherein the surface of the reservoirs has been functionalized to reduce or enhance adsorption of the particles to said surface.

18. The device of claim 11, wherein the elastomeric material comprises polyisoprene, polybutadiene, polychloroprene, polyisobutylene, poly(styrene-butadiene-styrene), polyurethane, poly(dimethylsiloxane) or silicone.

19. The device of claim 11, wherein the device is substantially transparent.

20. The device of claim 19, wherein the device further comprises an optical detection system.

21. The device of claim 11, wherein the measurement system comprises a four-point electrode system.

22. A method for sensing and characterizing particles by the Coulter principle, said method comprising:

(a) passing a liquid suspension of particles to be sensed and characterized through a conduit formed at least in part by an elastomeric material, wherein said conduit has an effective electrical impedance which is changed with the passage of each particle therethrough; and

(b) monitoring electrical current through or voltage across, said conduit to sense the approach of particles to, the presence and characteristics of particles passing through, or the departure of particles from, said conduit.

23. The method of claim 22, wherein the particle's residence time in the conduit is also measured.

24. The method of claim 22, wherein the conduit has a length, in the direction of the passage of the particles, of between about 1 and about 10 micrometers.

25. The method of claim 22, wherein the conduit has a cross-sectional area of less than about 1 μm^2.

26. The method of claim 22, further comprising a microfluidics or nanofluidics system for delivering the liquid suspension of particles to the conduit.

27. The method of claim 22, wherein the elastomeric material comprises polyisoprene, polybutadiene, polychloroprene, polyisobutylene, poly(styrene-butadiene-styrene), polyurethane, or silicone.

28. The method of claim 22, wherein the sensing of the approach of particles to, the presence and characteristics of particles passing through, or the departure of particles from, said conduit, initiates additional measurements or actions on said particles.

29. A method for sensing and characterizing particles by the Coulter principle, said method comprising:

(a) passing a liquid suspension of particles to be sensed and characterized through a conduit, wherein said conduit has an effective electrical impedance which is changed with the passage of each particle therethrough and wherein the conduit has a cross-sectional area of less than about 1 μm^2 and a length of less than about 50 μm; and

(b) monitoring electrical current through or voltage across, said conduit to sense the approach of particles to, the presence and characteristics of particles passing through, or the departure of particles from, said conduit.

30. The method of claim 29, wherein the particle's residence time in the conduit is also measured.

31. The method of claim 29, further comprising a microfluidics or nanofluidics system for delivering the liquid suspension of particles to the conduit.

32. The method of claim 29, wherein the conduit is formed at least in part by an elastomeric material.

33. The method of claim 32, wherein the elastomeric material comprises polyisoprene, polybutadiene, polychloroprene, polyisobutylene, poly(styrene-butadiene-styrene), polyurethane, or silicone.

34. The method of claim 29, wherein the conduit is substantially transparent.

35. The method of claim 34, further comprising the step of optically detecting the particles as the particles pass through said conduit.

36. The method of claim 29, wherein the electrical current and voltage are measured using a four-point electrode system.

37. The method of claim 29, wherein the sensing of the approach of particles to, the presence and characteristics of particles passing through, or the departure of particles from, said conduit, initiates additional measurements or actions on said particles.

38. A method for fabricating a microchip Coulter counter comprising the steps of:

a) providing a substrate having a plurality of electrodes; and

b) fluidly sealing an elastomeric cap on the top surface of the substrate and over at least two of said plurality of electrodes, whereby a conduit and two reservoirs are formed,

wherein said conduit has an effective electrical impedance which is changed with the passage of a particle therethrough.